User Science Report

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Organization and Mission

The User Science Division coordinates major facility activities related to users so that we can be more effective in communicating with the user community, strengthen existing scientific programs, foster the growth of new scientific programs, and raise the visibility of the exciting science produced by our users. The division consists of five sections: User Administration (Mary Anne Corwin), Information and Outreach (Lisa Miller), Beamline Development and Support (Steve Hulbert), Scientific Program Support (Ron Pindak), and Detectors and Controls (Peter Siddons). The major initiatives and accomplishments of the User Science Division and the NSLS user community for 2003 are summarized briefly below.

2003 Activities

This year has been eventful for the User Science Division. The year began with coordinating the user community in response to a Department of Energy /Basic Energy Sciences (DOE/BES) call for proposals to "Enhanced Research Capabilities at DOE X-ray and Neutron Facilities." Thanks to the effort of a large number of users and NSLS staff members, several major instrumentation proposals were submitted, including a new micro-beam x-ray diffraction instrument, an undulator-based small angle x-ray scattering beamline, and instrumentation upgrades for a number of powder/single crystal diffraction beamlines. Among them, the micro-diffraction instrument was funded in 2003, and the small angle scattering beamline will be funded in 2004. Both projects will take full advantage of the high brightness provided by the in-vacuum small gap undulator developed at the NSLS, and will provide two new world-class capabilities at the NSLS that are particularly important for nanoscience research. In addition, the input from the user community during the preparation of these proposals has been extremely valuable and will help us serve them better.

We soon turned our attention to working on the NSLS response to the DOE/BES "twenty-year facilities roadmap" review, and subsequently the science case for the NSLS-II proposal, an ultra-high brightness, medium energy storage ring. With the help of a large number of users, we organized more than a dozen scientific workshops, ranging from life sciences, materials/chemical sciences, and nanoscience to earth and environmental sciences. These focused workshops were very successful in identifying the grand challenges in the individual fields of research, and the impact of NSLS-II on them, as well as the technical challenges in the accelerator, insertion devices, optics and detectors. More importantly, these workshops have clearly demonstrated a great deal of excitement and support in the user community about the NSLS-II project.

The year continued with the exciting news that NSLS user Roderick MacKinnon from Rockefeller University shared the 2003 Nobel Prize in chemistry for his work on ion channel proteins. A very important part of

his work, the determination of numerous protein crysal structures, was done primarily at the Cornell High Energy Synchrotron Source and the NSLS. More good news this year for the NSLS macromolecular crystallography user community came when the BNL Biomedical Technology Research Resource for Macromolecular Crystallography, a center sponsored by the National Center for Research Resources (NCRR) of the National Institutes of Health (NIH), received its renewal funding for another five-year period. This supplements another grant sponsored by the Department of Energy (DOE) Office of Biological and Environmental Research (BER) for the same period. These two grants will fund a number of activities, including the support of full-time operation of the X25 wiggler beamline, the completion of construction and the ensuing commissioning and operation of a new undulator beamline for macromolecular crystallography at X29, and a major upgrade of beamline X25, which involves the replacement of its wiggler source by a novel small-gap undulator source and appropriate beamline optics upgrades to take advantage of the properties of the new source.

Figure 1. Beamline X6A, a new macromolecular crystallography beamline funded by the National Institutes of General Medical Sciences of the National Institutes of Health.

In between these exciting events, we have also completed a number of major beamline construction and upgrade projects:

- X6A beamline construction: A new bending magnet beamline, X6A, has been completed and started user operation. The beamline was funded by the National Institutes of General Medical Sciences of the National Institutes of Health (NIH-NIGMS) to meet the increasing demand in protein crystallography.

- X6B beamline construction: X6B is a new powder/single crystal diffraction beamline, designed to perform (1) time-resolved powder diffraction experiments, (2) combined x-ray spectroscopy and x-ray diffraction experiments, (3) single crystal diffraction experiments, and (4) electron density of excited states.

- X17 superconducting wiggler beamline upgrade: The upgrade involved the construction of two new experimental hutches to allow a dedicated hutch for a materials science instrument, a large volume press instrument, and a diamond anvil cell instrument. This upgrade will significantly increase the amount of beam time available to these user communities.

- X19A beamline upgrade: X19A is the premier low-energy x-ray beamline at the NSLS and has very high user demand. In 2003, a new monochromator was designed and installed to improve the cooling of the monochromator crystals. The new design has led to better energy and intensity stability of the beamline and ease of beamline operation.

- U5UA beamline upgrade: A refocusing mirror was added to provide the possibility of providing radiation to a second endstation. The focused beam size is on the order of 10 microns, making it ideally suited for the planned combined low-energy electron and photoemission microscopy endstation.

In addition, we have initiated several new beamline upgrade projects this year, including the X1A undulator beamline, the X13A elliptical polarizing wiggler beamline, the X21 wiggler beamline, and the X27 microprobe beamline. The completion of these projects will be very

important for the development of new scientific programs in nanoscience, soft and biomaterials, magnetism, advanced materials growth, and environmental science. We are also very fortunate to have seven very talented scientific and technical staff joining us this year to take on these projects and lead the development of new scientific programs.

There has also been steady progress in the detector development area this year. After successful a demonstration last year, several copies of the fast avalanche photodiode (APD) detector-electronics units have been installed at x-ray scattering beamlines. The large-angle curved gas proportional counter detector for time-resolved x-ray powder diffraction has been installed on two beamlines, one for testing purposes and the second for a user run. New software enabling time-slicing down to the microsecond time scale has also been implemented. Finally, several 96-element prototype silicon detectors with custom-designed integrated circuits, which each parallel-process input from 32 detector elements, are being assembled and will be deployed soon.

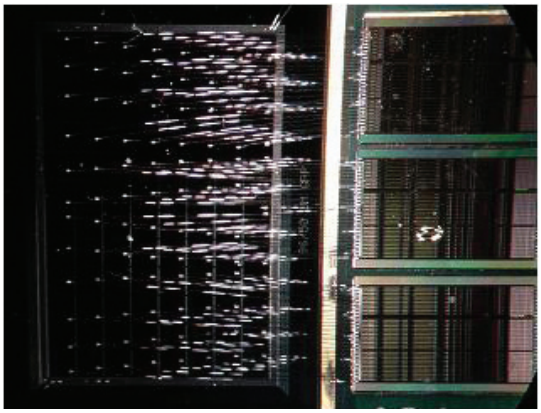

Figure 2. Three of the new 32-channel custom integrated circuits bonded to 96 silicon diode detectors. This configuration provides <250 eV resolution at 4 microseconds shaping time, or a count rate of >100 kHz per element at 0.5 microseconds shaping time.

With the addition of a full-time programmer this year, the User Administration office has made significant progress in the development of a new online proposal system to integrate proposal submission, safety approval, proposal review, beamtime allocation, and beamtime scheduling. We appreciate greatly the effort by a large number of participating research teams (PRTs), users, and NSLS staff, who provided valuable input and recommendations throughout the process. Testing of the system will begin in 2004.

Finally, we continue to take more immediate steps to enhance user science at NSLS. First, a short course on EXAFS data collection and analysis was held again this past summer with the help of many experienced users. This hands-on workshop provided both new and experienced users with exposure to EXAFS theory, data collection, and analysis. Feedback on the EXAFS short course has been so extremely positive that it has become an annual event. Second, a regular series of science highlight articles is now published on the NSLS website to facilitate the dissemination of exciting scientific results obtained at NSLS beamlines to the NSLS user community, as well as the wider scientific community. Third, a new symposium series has been established at the NSLS to give staff and users an opportunity to hear about cutting-edge synchrotron research that is performed worldwide. Upcoming seminars are now listed on the NSLS homepage for easy access to the schedule. In addition to these activities, the NSLS staff has been helping the BNL Center for Functional Nanomaterials (CFN) establish and launch a CFN user program, exploring ways to coordinate the NSLS and CFN user programs.